Population Biology

This is a short (3-week) graduate course on population biology. We will cover mathematical and computational modeling of “populations” (of organisms, genotypes, molecules, etcetera). The main goal of the course is to give you the tools to read and interpret models found in the literature, and to get a start on creating your own models. We’ll create and visualize random and deterministic (nonrandom) models, and show how to move from one to the other. We’ll learn how to understand the short-and long-term behavior of systems, categorizing stable points and periodic orbits. Along the way we’ll cover some aspects of probability (means, variances, a few distributions) and simulation, as well as some linear algebra (matrix products, changes of basis, eigenvalues and eigenvectors).

Reading: A good reference would be A Biologist’s Guide to Mathematical Modeling in Ecology and Evolution, by Sarah P. Otto and Troy Day. We’ll cover a lot of things in this book—and, it has great background on the math we use—but not in the same order.

Software: We’ll do a lot of work (simulation, plotting) in jupyter notebooks. Towards the end we’ll also start using the individual-based simulator SLiM, which takes care of a lot of messy details for us.

Jupyter notebooks: You can find these in notebooks/.

Schedule:

Day 1 (Wednesday, 1/30) - individual-based models Building and visualizing individual-based models; finding means and variances; differential equation limits. Example: exponential, logistic population growth.
  • notebook

Day 2 (Friday, 2/1) - taking the limit with one-dimensional systems
  The (deterministic) logistic model: stability, cycles, and chaos.
  • notebook (continued from before)

Day 3 (Monday, 2/4) - Differential equations, and higher dimensions
  Building and visualizing individual-based models: more variables. Example: Lotka-Volterra dynamics
  • notebook

Day 4 (Wednesday, 2/6) - not everyone is the same
  Linear algebra to concisely describe stage-structured linear population models.

Day 5 (Friday, 2/9) - eigenpopulations
  Linear algebra for linear models: using eigenvalues and eigenvectors to completely understand stage-structured population models.
Day 6 (Monday, 2/12) - local analysis General behaviors for more-than-one-dimensional systems: using locally linear approximations to understand the local behavior of systems.

Day 7 (Wednesday, 2/14) - equilibria and stability Using information about fixed points to understand long-term behavior.

Day 8 (Wednesday, 2/14) - adding back randomness What does the behavior of a deterministic model tell you about the random model that it’s approximating? Simulation and heuristic methods.

Day 9 (Friday, 2/16) - spatial models in SLiM How to implement a spatial model in SLiM.

Day 10 (Monday, 2/19) - range expansions Translating what we know about nonspatial systems to construct a two-population spatial model of invasion and coexistence.
Resources and policies

Campus resources to support your learning

Tutoring and Academic Engagement Center: Drop-in math and writing support in addition to tutoring, study skills support, and Class Encore. Located in the 4th Floor Knight Library. (541) 346-3226, engage@uoregon.edu

Counseling Center: Call anytime to speak with a therapist who can provide support and connect you with resources. Located on the 2nd Floor of the Health Center. (541) 346-3227.

Accessible Education Center: The University of Oregon is working to create inclusive learning environments. The instructor believes strongly in creating inclusive learning environments. If there are aspects of the instruction or design of this course that result in barriers to your participation, please notify us as soon as possible. You are also encouraged to contact the Accessible Education Center. If you are not a student with a documented disability, but you would like for us to know about class issues that will impact your ability to learn, we encourage you to come visit during office hours so that we can strategize how you can get the most out of this course. Located on the 1st Floor of Oregon Hall (541) 346-1155, uaecc@uoregon.edu

Center for Multicultural Academic Excellence (CMAE): has a mission to promote student retention and persistence for historically underrepresented and underserved populations. We develop and implement programs and services that support retention, academic excellence, and success at the UO and beyond. We reaffirm our commitment to all students, including undocumented and tuition equity students. Located on the 1st Floor of Oregon Hall (541) 346-3479, cmae@uoregon.edu

The UO Access Shuttle is an on-campus ride service provided at no cost to students with conditions that limit mobility. More information and a sign-up form can be found on the parking & transportation department website: https://parking.uoregon.edu/content/access-shuttle.

Safe Ride is an assault prevention shuttle that works to provide free, inclusive, and accessible alternatives to traveling alone at night for UO students, faculty, and staff. Call 541-346-7433 ext 2 or visit pages.uoregon.edu/saferide “We are a schedule-ahead service and riders can (1) call once we open to schedule a ride with a dispatcher or (2) leave a voicemail on the day of their ride request. We do not call riders ahead of time to confirm due to capacity constraints, but riders are always welcome to call us to double-check that their ride was scheduled. We are a feminist, ‘for-the-students/by-the-students’ organization and operate out of the Women’s Center in EMU 12F.”
Academic integrity

All students will be expected to adhere to the University’s guidelines on academic integrity as outlined in the Student Conduct Code: https://policies.uoregon.edu/vol-3-administration-student-affairs/ch-1-conduct/student-conduct-code. Academic misconduct includes cheating (“any act of deception by which a student misrepresents or misleadingly demonstrates that the student has mastered information on an academic exercise that the student has not mastered”), and plagiarism (“using the ideas or writings of another as one’s own”). We have a zero tolerance policy for academic dishonesty. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures.

Discrimination and Harassment

Prohibited Discrimination and Harassment: Any student who has experienced sexual assault, relationship violence, sex or gender-based bullying, stalking, and/or sexual harassment may seek resources and help at safe.uoregon.edu. To get help by phone, a student can also call either the UO’s 24-hour hotline at 541-346-7244 (SAFE), or the non-confidential Title IX Coordinator at 541-346-8136. From the SAFE website, students may also connect to Callisto, a confidential, third-party reporting site that is not a part of the university.

Students experiencing any other form of discrimination or harassment can find information at respect.uoregon.edu or aaeo.uoregon.edu or contact the non-confidential AAEO office at 541-346-3123 or the Dean of Students Office at 541-346-3216 for help. As UO policy has different reporting requirements based on the nature of the reported harassment or discrimination, additional information about reporting requirements for discrimination or harassment unrelated to sexual assault, relationship violence, sex or gender based bullying, stalking, and/or sexual harassment is available at Discrimination & Harassment.

Reporting: The instructor of this class is a Student-Directed Employee. If you disclose discrimination or harassment to me, I will respond to you with respect and kindness. I will listen to you, and will be sensitive to your needs and requests. I will not judge you. I will support you. I will only report the information shared to the university administration when you as the student requests that the information be reported (unless someone is in imminent risk of serious harm or is a minor). Please note the difference between ‘privacy’ and ‘confidentiality.’ As a Student-Directed Employee I can offer privacy because I am not required to report certain information to the university. However, I cannot be bound by confidentiality in the same way that a counselor or attorney is. Confidential resources such as these means that information shared is protected by federal and state laws. Any information that I as a student-directed employee receive may still be accessed by university or court proceedings. This means, for example, that I could still be called as a witness or required to turn over any related documents or notes that I keep.
Please note also that I am required to report all other forms of prohibited
discrimination or harassment to the university administration. Specific details
about confidentiality of information and reporting obligations of employees can
be found at titleix.uoregon.edu.

UO employees, including faculty, staff, and GEs, are mandatory reporters of
child abuse (pertaining to individuals under age 18). This statement is to advise
you that your disclosure of information about child abuse to the instructor may
trigger a legal duty to report that information to the designated authorities.